Assessment Predictors of Hospital Acquired Anemia among Critically Ill Patients

Nesma Mostafa Saied Mostafa [1,2]. Sheren Mohammed Abed Ellatief Gad Diab [3], Atteia Gad El hak Ibrahim[4] and Hanaa Atef Elbana[5]

[1]Master student of Critical Care Nursing, Faculty of Nursing, Tanta University, Egypt.
[2]Nursing Specialist at Kafer Elsheikh University Hospital, Egypt.
[3]Assistant Prof. of Critical Care and Emergency Nursing, Faculty of Nursing, Tanta University, Egypt.
[4]Assist .Prof. of Anesthesia Surgical I CU and Pain Medicine Faculty of Medicine Tanta University, Egypt .
[5]Lecturer of Critical Care and Emergency Nursing, Faculty of Nursing, Tanta University, Egypt

Corresponding author: Nesma Mostafa Saied Mostafa
Email: nesma .mostafa9290@gmail.com

Abstract

Background Hospital acquired anemia is a frequent complication in intensive care units that leads to negative outcomes, higher morbidity and mortality for critically ill patients .**Aim** Assess predictors of hospital acquired anemia among critically ill patients. **Design**: A descriptive correlation study design **Setting**: This study was conducted at Surgical Intensive Care Unit at Tanta Emergency Hospital affiliated to Ministry of higher education and scientific research. **Subjects**: Purposive sampling of 100 patients who met all inclusion criteria was included. **Tools**: Three tools were used for data collection. **Tool (I):** Hospital Acquired Anemia Assessment Tool**, Tool (II):** Predictors of Hospital Acquired Anemia Assessment Tool and **Tool (III):** Physiological Indices Assessment Tool. **Result**: The mean hemoglobin level decreased significantly from (13.17± 1.07) on admission to (9.94± 1.73) at 7th day of the study where p (0.000*), significance relation was observed between diagnosis and severity of anemia on 3rd day and 7th day where p (0.047*) and (0.037*) respectively and more than half of studied patients had hospital acquired anemia related nursing practice throughout the period of study. **Conclusion**: The studied patients developed Hospital acquired anemia during their ICU stay. There were statistically significance relation between diagnosis and severity of anemia on 3rd day and 7th day of the study. Also there were significant correlation among level of consciousness, physiological indices regarding respiratory rate, MAP and severity of anemia. **Recommendation**: Preform a comprehensive patient monitoring and assessment for early detection and intervention of hospital acquired anemia.

Key words: - Critical ill patient, Hospital acquired anemia, Predictors of anemia

Introduction

Anemia is frequently seen in critically ill patients in the ICU, presenting a common clinical issue **(Sole ,Klein&Mosely ., 2020).** Most of the remaining patients develop anemia while in the ICU, with more than 90% of ICU patients being anaemic by the third day. The risk of developing anemia rises with each extra day spent in the ICU (**Prin et al .,2021)**. Anemia is described as a decrease in the quantity of red blood cells, the amount of haemoglobin, or both resulting in a lower ability to carry oxygen in the blood**.(Yoshida ,Prudent &D'Alessandro ., 2019)**

There are three accepted definitions of anemia. The World Health Organization (WHO) created the most prevalent definition. It is the most conservative as well as the easiest. Haemoglobin level of less than 12 g/dL for women and less than 13 g/dL for men is considered anemia. But the definition doesn't take into consideration anemia grades or the typical variances that occur in people of different ages and races. **(World Health Organization, 2021).**

All over the world, the incidence of (HAA) up to 25%-75% among critically ill patients **(Salah & Mohamed, 2018**), Annually at Surgical Intensive Care Unit, Emergency Hospital at Gharbia Governate, Egypt, according to Statistical record centre in Tanta University 2023, there about 250 patients are admitted to intensive care units **(Statistical Record Centre in Tanta., 2023)**

Anemia that is specifically related to hospital stays is known as hospital-acquired anemia. Regardless of the numerical starting point, there is a decrease in haemoglobin during hospitalization as compared to the haemoglobin on admission **(Bressman, Jhang ,McClaskey &Ginzburg ., 2021).** Although there hasn't been much focus on hospital-acquired anemia, some research has been secondary to the risks associated with transfusion phlebotomy at different institutions **(Padhi, 2023).**

Hospital-acquired anaemia is often insidious in onset **(Whitehead et al., 2019).** Drops in hemoglobin from many iatrogenic causes can take several days to become clinically evident, and the incremental diminishments are often written off by most clinicians **(Chandrashekar, 2018).** When symptoms are present, they are often vague with a slow progression of pallor, fatigue, malaise, shortness of breath, headaches, tachycardia, or dizziness. In clinical practice, particularly during acute hospital stays.**(Koch et al., 2017).**

Hospital acquired anemia is highly complex and can be caused by a variety of factors only some of which may be under the medical staff's control. According to **(Meybohm et al. ,2020)**, patients can suffer from marrow suppression caused by inflammatory cytokines, nutritional deficits, medicinal suppression of RBC production, real bleeding, surgical and procedural losses, and more occult losses through phlebotomy. There are other reasons for anemia besides actual RBC loss, which include dilution effects **(Helmer et al., 2022).**

Other patient factors that increase hospital-acquired anemia include nutritional deficiency, iron deficiency, and impaired systemic iron transport, as well as impaired erythropoietin production,phlebotomy ,Coagulopathies and gastric bleeding caused by stress also play a role in hospital-acquired anaemia **(Shander & Corwin, 2020);** Duration of hospitalization and severity of illness are other risk factor **(Elmetwalli ,Khalil &Reshia ., 2021).**

The outcomes of hospital acquired anemia are death and readmission within 30 days of discharge; these are probably due to the cumulative effect of daily phlebotomy and the greater probability of more procedures with a longer stay in the hospital, especially when seriously unwell. **(Quinn et al., 2019) & (Bodley et al., 2021).**

Critical care nurses have a major role in preventing acquired anaemia through identifying the risk patient groups, assessing risk factors contributing to anaemia, monitoring of O_2 status as well as haematological ones, minimizing blood loss through excessive blood sampling, and using of blood conservation strategies in ICUs .Assessing patients' nutritional status through revising policies, procedures, and feeding protocols related to nutritional support practices, evaluating the adequacy of nutritional support, and reasons impeding adequate delivery(**Briggs ,Hawkins Hodgs &Monk .,2019)**

Significance of the study

Attention to ICU acquired anemia is important because it can impact negatively the critical ill patient, which lead to increase length of hospital stay, increase need for blood transfusion that associated with major complication. Hospital-Acquired Anemia affects approximately 25% to 74 % of patients during their stay in the hospital **(WHO, 2021) & (Czempik, Wilczek ,Herzyk &Krzych ., 2022)**. Similarly, 76.9% of critically ill patients developed HAA, with an 11 g/dl hemoglobin cut off for adult males and 10.6 g/dl hemoglobin cut off for adult females, so the aim of this study is to assess predictors of hospital acquired anemia among critically ill patients **(Gonce&Fontaine, 2019) & (Rawal ,Kumar ,Yadav &Singh ., 2016).**

Aim of the study: - Assess predictors of hospital acquired anemia among critically ill patients.

Research questions:

1. What are the main predictors related to hospital acquired anemia among critically ill patients?
2. What was the relation between the predictors of hospital acquired anemia, severity of anemia and physiological indices among critically ill patient?

Subjects and Method:

Research design

A descriptive correlational research design was utilized to conduct this study.

Setting

The study was conducted at Surgical Intensive Care Unit at Tanta Emergency Hospital, which is affiliated to Ministry of Higher Education and Scientific Research. It was prepared and equipped with five wards in ICU, each ward equipped with four beds, the total number of beds was twenty.

Subjects:

A purposive sampling of 100 patients was selected. The sample size was estimated using Epi Info 7 Statistical Program, using the following parameters: Total patients are 250 per year 2022 Confidence level=99.9%
Expected frequency=50% Accepted error=5%
Confidence coefficient=95%

The following criteria were used for selecting sample:

The inclusion criteria:

- Adult patients aged 21 to 60 years.
- Both sex.
- Newly admitted patient within 24 hours.

The exclusion criteria:

- Patient with bleeding disorders.
- Patient who had anemia as the primary cause of ICU admission.

Tools of data collection:

Three tools were used in the current study to assess predictors of hospital acquired anemia among critically ill patients at surgical intensive care unit, it was including the following:

Tool (I): Hospital Acquired Anemia Assessment Tool: This tool was developed by the researcher, after reviewing the related literature **(Salah, Mohamed,. 2018) & (Holland , Peralta ,. 2020)** and was consist of two parts:

Part (a): Demographic Data of the Patients: It was include, patient`s code, age, sex.

Part (b): Patient`s Clinical Data: It included diagnosis, past medical and surgical history, present medical or surgical history, hemoglobin level, haematocrit level and red blood cell count.

Tool (II): Predictors of Hospital Acquired Anemia Assessment Tools: It was divided into four parts,

Part(a): Modified APACHE II scoring: it was developed by (**Knaus and Draper,.1985)** and adapted by researcher to assess severity of disease level and outcome , degree of diagnostic and therapeutic intervention The Modified APACHE II include two domains (Acute Physiological Score and Age Point). Acute Physiological Score included (Mean Bp (mmhg), Serum sodium (mmol/L), Serum potassium (mmol/L), Serum creatinine (mmol/L), Glasgow coma scale) and Age Point which classified according to patient age (≤ 44, 45-54, 55-60). The Modified APACHE II is based on the numerical value assigned to an individual's Acute Physiological Score and Age Points.

The patient was assessed for criteria and calculate scoring system as follow:

Physiological Score: best mean normal blood pressure (Bp) 0 points and extreme end of high or low abnormal 4 points, best Serum sodium(mmol/L) 0 points and extreme end of high or low abnormal 4 points, best Serum potassium (mmol/L) 0 points and extreme end of high or low abnormal 4 points, best Serum creatinine (mmol/L) 0 points and extreme end of high or low abnormal 4 points and Glasgow coma scale score range from (0-12) as subtract patient total score from mean GCS score. **Age Points** which classified according to patient age: (≤ 44) 0 points (45-54) 2 points and (55-60) 3 points

Scoring System:

The Patient was assessed for criteria and calculates scoring system that ranged from 0 to 4 on each side of normal value. Zero score represents normal values. An increase to 4 indicating the extreme end of high or low abnormal ,Total Scoring was calculate of all physiological score, Glasgow coma scale and Age points if total score was ≤10 this indicated decrease severity of disease (good outcome)and ≥10 indicated increase severity of disease(poor outcome).

Part (b): The Glasgow Coma Scale (GCS):

This scale was developed by**(Graham Teasdale and Bryan Jennet ., 1974)** to assess patient's level of consciousness. The GCS include three domains eye opening, verbal response and motor response. GCS is based on the numerical value assigned to an individual's best eye opening, verbal, and motor responses. Each response was scored separately and totaled, scores range from 3 to 15.

Scoring system:

The patient was assessed for criteria and calculates scoring system: best eye-opening maximum 4 points and minimum 1, verbal response maximum 5 points and minimum 1, motor response maximum 6 points and minimum 1.coma), GCS ≥ 13,Moderate neurological deficits (Moderate coma), GCS 9-12 and Severe neurological deficits (sever coma), GCS 3-8.

Part(c): Predictors of Hospital Acquired Anemia Related to Patient; such as severity of anaemia, Type of nutritional intake, Total calories intake through calculating 24 hrs, bleeding, drug induced anemia as (anticoagulants therapy, Antiplatelet agent, non-steroidal anti- inflammatory drugs, antibiotic as (Cephalosporin's, quinolones), bone marrow suppressant, and recent trauma or surgery,

Part (d): Predictors of Hospital Acquired Anemia Related to Nursing practice: such as invasive procedures (Arterial and venous catheters insertion, drainage system, wounds, phlebotomy).

Tool (III): Physiological Indices Assessment Tool (Veerabhadrappa et al., 2021).

It was developed by the researcher after reviewing of the related literature. It was used to evaluate patients' oxygen saturation, heart rate, respiratory rate, mean arterial blood pressure, systolic and diastolic blood pressure and core body temperature.

Scoring system:

The physiological indices explained presented as mean and standard deviation.

Method:

The study was accomplished through the following steps:

1. Administrative process:

An official permission for data collection was obtained from the responsible authorities at the Faculty of Nursing, Tanta University to the directors of Surgical Intensive Care Unit Emergency Hospital in Tanta University Hospital to carry out the study.

2. Ethical and Legal Consideration:

- Ethical committee approval of the Faculty of Nursing at Tanta University approval was obtained, code No (191-1-2023) and Ethical committee of Faculty of Medicine, code No (32264MS30/1/23).
- Nature of the study was not causing any harm or pain to the entire subjects.
- Confidentiality of the data and patient privacy were respected.
- A code number was used instead of names.
- Informed consent was be taken from every patients if he/she was conscious or from one of the first degree family members if the patients was un conscious after explaining the aim of study to participate in the study and including the right to withdrawal at any time .
- All participants were informed about the purpose of the study and right to withdraw from the study at any time if desired.

3. Tool Development:

- Tool I, tool II part c & d, and III were developed by the researcher after extensive review of the relevant literatures, while tool II part (a) was developed by (**Knaus and Draper., 1985).**
- Tool II part (b) was developed by (**Graham Teasdale & Bryan Jennt, 1974)**

4. Tools Validity:

All tools were tested by five panels of experts in the field of critical care and emergency nursing to check content validity and clarity of questionnaire. They were tested for comprehensive appropriateness and modification was done.

5. A pilot Study:

It was conducted before the study, on 10% (10) patients in order to test the clarity, feasibility and applicability of tool and determine any obstacles that may encountered during the period of data collection accordingly, needed modification was done, and pilot study was excluded from the total number of the study subjects.

Data collection for the present study was conducted over six months within the period from the end of March to the end of August 2023

6. Reliability:

Cronbach's Alpha for tool I is 0.811, tool II is 0.923 and tool III is 0.923.

7. The present study was carried as the following, Patients were assessed by using tool (I, II, III) on admission to obtain base line data and daily for seven consecutive days.

- The mean score was estimated on the 3rd day, the 5th day and 7th day of admission to assess predictors of hospital acquired anemia among critically ill patients.
- Through tool I, it included demographic data of the patients, it included patient`s code, age, sex. And patient`s clinical data**,** It included diagnosis, past medical and surgical history, present medical or surgical history, hemoglobin level, hematocrit level and red blood cell count.

- Tool II, Predictors of Hospital Acquired Anemia Assessment Tools**:** It was divided into four parts, Modified APACHE II scoring (assess severity of disease level and outcome, degree of diagnostic and therapeutic intervention).
- The Modified APACHE II include two domains (Acute Physiological Score and Age Point)..
- The Glasgow Coma Scale (GCS): This scale assess patient's level of consciousness.
- Predictors of Hospital Acquired Anemia Related to Patient**;** such as severity of anemia, type of nutritional intake ,total calories intake through calculating 24 hrs, drug induced anemia as (anticoagulants therapy, Antiplatelet agent, non-steroidal anti- inflammatory drugs, antibiotic as (Cephalosporin's, quinolones).and bone marrow suppressant, recent trauma or surgery, Tool III, Physiological Indices Assessment Tool**;** It evaluated patients' oxygen saturation, heart rate, respiratory rate, mean arterial blood pressure, systolic and diastolic blood pressure and core body temperature

Results

Table (1) Shows distribution of the studied patients regarding their socio demographic characteristics.

Regarding this table, about (44%) of patients were in age group of (40-<50) years with mean ± SD (45.41±11.379). Regarding gender about more than half (51%) of patients were female.

Table (2) Shows distribution of the studied patients regarding their clinical data.

Regarding diagnosis, the results showed that near half (45%) of studied patients had neurological disease. **Concerning past medical history**, it was found that near half (45%) of patients had heart disease. Also, it was found that more than one third (36 %) of patients had diabetic disease and (5%) had hepatic failure.

As regarding past surgical history, it was found that about more than one third (35%) of patient had no previous surgery (5%) of patients had hysterectomy.

Also, the mean patient's weight was **(**84.05±8.260)**. Regarding calories intake**, the mean daily calories intake was (2530.10±244.812).

Table (3) Show distribution of the studied patients regarding Laboratory investigation.

Regarding hemoglobin level, it was noticed that mean hemoglobin level on admission decreased significantly from (13.17±1.07) to (9.94±1.73) on the 7_{th} day of the study where p value was (0.000*).

Concerning hematocrit, it was noticed that mean hematocrit level on admission was (35.61±3.47) and mean on 7^{th} day (29.73±5.49) with statistical significance where p value was (0.000*) respectively.

In relation to red blood count ($\times 10^3$), it found that mean count on admission decreased significantly from (4.27±0.90) to (3.41±0.52) on the7^{th} day of the study where p value was (0,000*).

Table (4) Show distribution of the studied critically ill patients according their total modified APACHE level

it was found that majority (91%) of patients had increase disease severity (poor outcome) and the rest (9%) of patients had decrease disease severity with mean± SD (14.81±3.714).

Table (5) shows distribution of the studied critically ill patients according predictors of hospital acquired anemia related to patients throughout periods of the study.

Regarding severity of anemia according to hemoglobin level, it was observed that (100%)of patient on admission had mild anemia according to hemoglobin level and this significantly decrease to half (54%) on the 7^{th} day of the study, at the same time the percent of patients with moderate anemia increase significantly from 3^{rd} day to (28%) and

(40%)on 5th day and on the 7th day of study respectively with statistical significance where p value was (0.000*) .

Regarding Types of calories intake, the majority (81.0%) had enteral and about (19.0%) had parenteral intake on admission, with statistical significance where p value was (0.007*).

Concerning nutritional intake through 24hrs,It was observed that the mean 24hrs enteral intake decrease significantly from (2085) on admission to(2023)on the 7th day of the study where p(0.00*). **Also Drug induced anemia** the majority of patients (71.0%) ,(68.0%) had anticoagulants and antiplatelet therapy on admission with statistical significance difference throughout period of study where p value was (0.000*) and (0.04*) respectively **.** On other hand 90.0%of patients had non-steroidal anti-inflammatory drugs on the 3rd day of study,

Regarding antibiotics, the majority (89.0%) in 3rd day had cephalosporin and three fourth (75%) at 7th day had Quinolones throughout period of study

Concerning bone marrow suppressant drugs the majority (81.0%) had on the 5th and at the 7th day of the study..

Related to recent trauma or surgery, the majority (81.0%) on 5th and 7thof the study had recent surgery.

Table (6) Show distribution of the studied critically ill patients according predictors of hospital acquired anemia related to nursing practice throughout periods of study.

Concerning predictors of anemia related to nursing practice it was showed that more than two third (69%) had arterial catheter insertion on the 7th day of study compared to more than half (56 %) on admission.

Regarding venous catheter insertion, it was found that the majority (97%) had venous catheter on the 7th day of study compared to (95%) on admission.

Regarding drainage system care, it was revealed that, three fourth (75%) had drainage system at 7th day of the study. **Concerning to Wound care,** the majority if studied sample (87%) had wound care on 7th day of study compared to (83%) on admission**.**

On other hand, about three forth (72%) had phlebotomy on7th day compared to about half (45%) on admission throughout period of study.

Table (7) Show Relation between diagnosis of the studied critically ill patients and their mean hemoglobin level.

This table showed that, there was significant relation observed between diagnosis of critically ill patients and mean hemoglobin level on 3rd day and on 7th day where P value was (0.044*) and (0.031*) respectively.

Table (8) Show relation between diagnosis of the studied critically ill patients and their severity of anemia according to hemoglobin level.

This table showed, there was significant relation observed between diagnosis and severity of anemia at 3rd day and the 7th day of study where P value was (0.0478) and (0.037***) respectively.**

Table (9) Show Correlation between level of consciousness of the studied critically ill patients and their laboratory investigations and severity of anemia throughout the periods of the study.

This table showed, there significance correlation observed between level of consciousness, RBCs count ($\times 10^3$) and severity of anemia at 5th day where p value was (0.018*) and (0.048*) respectively. **Furthermore**, there was significant correlation between level of consciousness and RBCs count ($\times 10^3$) at 7th day where P value (0.013*).

Table (10) Show Correlation between severity of anemia of the studied critically ill patients and their physiological indices throughout the periods of the study.

This table revealed that, significance correlation observed between severity of anemia and physiological indices regarding respiratory rate , mean arterial blood pressure and diastolic blood pressure on the 7th day where p value was (0.021*,0.027*, 0.023*) respectively.

Table (1): Distribution of the studied critically ill patients according their socio-demographic characteristics.

Characteristics	The studied patients (n=100)	
	N	%
Age (in years)		
(21-<30)	12	12.0
(30-<40)	19	19.0
(40-<50)	44	44.0
(50-60)	25	25.0
Range	**(21-60)**	
Mean ± SD	**45.41±11.379**	
Gender		
Male	49	49.0
Female	51	51.0

Table (2): Distribution of the studied critically ill patients according their clinical data.

Clinical data	The studied patients (n=100)	
	N	%
Diagnosis		
Neurological disease	45	45.0
Heart disease	15	15.0
Infectious disease	10	10.0
Post-operative surgery	30	30.0
Past medical history		
None	19	19.0
Respiratory diseases	23	23.0
Heart diseases	45	45.0
Renal diseases	16	16.0
Cancer	11	11.0
Hepatic failure	5	5.0
Neurological diseases	12	12.0
Diabetic disease	36	36.0
Past surgical history		
None	35	35.0
Appendectomy	15	15.0
Thyroidectomy	5	5.0
Hemorrhoids/Anal fissure	8	8.0
Hysterectomy	5	5.0
Cholecystectomy	17	17.0
Hernia	15	15.0
Patient weight (in Kg) **Range** **Mean ± SD**	(60-98) 84.05±8.260	
Calories intake **Range** **Mean ± SD**	(1800-2975) 2530.10±244.812	

Table (3): Distribution of the studied critically ill patients according the laboratory investigations

Lab data	The studied patients (n=100) Range Mean ± SD				F P
	On admission	At 3rd day	At 5th day	At 7th day	
Hemoglobin	(12.0-16.1) 13.17±1.07	(8.3-15.7) 11.73±1.34	(8-15) 10.82±1.46	(0-14.7) 9.94±1.73	**94.26** **0.000***
Hematocrit	(29.9-48.7) 35.61±3.47	(4.0-47.5) 33.01±4.87	(20.6-48.3) 31.39±4.65	(0-44.8) 29.73±5.49	**28.65** **0.000***
RBCs count (×10^3)	(2.8-9.9) 4.27±0.90	(2.6-5.6) 3.79±0.55	(2.5-5.5) 3.61±0.56	(2.0-5.3) 3.41±0.52	**32.04** **0.000***

* Significant at level P<0.05

Table (4): Distribution of the studied critically ill patients according their total modified APACHE level

Total modified APACHE Level	The studied patients (n=100)	
	N	%
Decreased disease severity (Good outcome)	9	9.0
Increased disease severity (Poor outcome)	91	91.0
Range	**(8-24)**	
Mean ± SD	**14.81±3.714**	

<10 (Decreased disease severity - Good outcome) ≥10 (Increased disease severity - Poor outcome

Table (5): Distribution of the studied critically ill patients according predictors of hospital acquired anemia related to patient throughout periods the study.

Predictors related to patient	The studied patients (n=100)								χ^2 P
	On admission		At 3rd day		At 5th Day		At 7th Day		
	N	%	N	%	N	%	N	%	
Severity of anemia according to hemoglobin level (g/dl)									
Mild (>10)	100.0	100.0	97	97.0	72	2.0	4	54.0	**99.49**
Moderate (8-<10)	0.0	0.0	3	3.0	28	28.0	40	40.0	**0.000***
Severe (6-<8)	0.0	0.0	0	0.0	0	0.0	6	6.0	
Range	**(11.5-16.1)**		**(8.3-15.7)**		**(8-15)**		**(6-14.8)**		**F=100.53**
Mean ± SD	**13.17±1.07**		**11.73±1.34**		**10.82±1.46**		**9.94±1.73**		**P=0.000***
Type of nutrition intake									
Enteral									
Present	81	81.0	92	92.0	93	93.0	94	94.0	**12.22**
Absent	19	19.0	8	8.0	7	7.0	6	6.0	**0.007***
Parenteral									
Present	19	19.0	8	8.0	7	7.0	6	6.0	0.007*
Absent	81	81.0	92	92.0	93	93.0	94	94.0	12.22
Total calories intake through calculating 24 hrs									
Enteral									
Min	1400		1500		1690		1250		
Max	2575		2675		2875		2600		**F=43.98**
Mean	2085.37		2253.00		2398.05		2023.95		**P=0.00***
SD	240.92		244.57		246.03		261.98		
Parenteral									
Min	1200		1150		1200		1050		
Max	2800		2560		2660		2260		F=0.23
Mean	1858.18		1900.83		1838.33		1736.00		P=0.87
SD	480.45		481.77		535.29		364.48		
Drug induced anemia									
Anticoagulant ants therapy									
Present	71	71.0	88	88.0	91	91.0	89	89.0	**19.86**
Absent	29	29.0	12	12.0	9	9.0	11	11.0	**0.000***
Anti-platelet agents									
Present	68	68.0	80	80.0	81	81.0	83	83.0	**8.04**
Absent	32	0	20	20.0	19	19.0	17	17.0	**0.04***

Non-steroidal anti-inflammatory drugs									
Present	89	89.0	90	90.0	90	90.0	88	88.0	0.29
Absent	11	11.0	10	10.0	10	10.0	12	12.0	0.96
Anti-biotic									
Cephalosporins									
Present	88	88.0	89	89.0	88	88.0	88	88.0	0.07
Absent	12	12.0	11	11.0	12	12.0	12	12.0	0.99
Quinolones									
Present	76	76.0	76	76.0	77	77.0	75	75.0	0.11
Absent	24	24.0	24	24.0	23	23.0	25	25.0	0.99
Bone marrow suppressant drugs									
Present	78	78.0	80	80.0	81	81.0	81	81.0	0.37
Absent	22	22.0	20	20.0	19	19.0	19	19.0	0.94
Recent trauma or surgery									
Present	75	75.0	80	80.0	81	81.0	81	81.0	1.51
Absent	25	25.0	20	20.0	19	19.0	19	19.0	0.68

* Significant at level P< 0.05

Table (6): Distribution of the studied critically ill patients according predictors of hospital acquired anemia related to nursing practice throughout periods of study.

Predictors related to nursing practice	The studied patients (n=100)								χ^2 P
	On Admission		At 3rd Day		At 5th Day		At 7th Day		
	N	%	N	%	N	%	N	%	
Invasive procedures									
Arterial Cather insertion									
Present	56	56.0	57	57.0	64	64.0	69	69.0	0.12
Absent	44	44.0	43	43.0	36	36.0	31	31.0	0.99
Venous Cather insertion									
Present	95	95.0	96	96.0	96	96.0	97	97.0	0.23
Absent	5	5.0	4	4.0	4	4.0	3	3.0	0.97
Drainage system									
Present	51	51.0	54	54.0	63	63.0	75	75.0	0.43
Absent	49	49.0	46	46.0	37	37.0	25	25.0	0.93
Wound									
Present	83	83.0	85	85.0	87	87.0	87	87.0	0.88
Absent	17	17.0	15	15.0	13	13.0	13	13.0	0.83
Phlebotomy									
Present	55	55.0	59	59.0	63	63.0	72	72.0	0.79
Absent	45	45.0	41	41.0	37	37.0	28	28.0	0.38

Table (7): Relation between diagnosis of the studied critically ill patients and their mean hemoglobin level.

Diagnosis	The studied patients (n=100) Hemoglobin level Mean ± SD			
	On Admission	At 3rd day	At 5th day	At 7th day
Neurological disease	12.94±0.77	11.40±1.09	10.49±1.32	9.44±1.98
Heart disease	**13.82±1.43**	11.96±2.19	11.11±2.06	10.05±1.33
Infectious disease	13.03±1.18	11.85±1.41	10.59±1.84	10.00±2.14
Post-operative surgery	13.24±1.13	**12.08±1.06**	**11.26±1.06**	**10.63±1.03**
F	**1.810**	**2.796**	2.028	**3.090**
P	**0.150**	**0.044***	0.115	**0.031***

* Significant at level P<0.0

Table (8): Relation between diagnosis of the studied critically ill patients and their severity of anemia according to hemoglobin level.

Diagnosis	The studied patients (n=100) Severity of anemia Mean ± SD			
	On Admission	At 3rd day	At 5th day	At 7th day
Neurological disease	12.94±0.77	11.40±1.09	10.48±1.32	9.67±1.37
Heart disease	**13.82±1.43**	11.96±2.19	11.11±2.06	10.05±1.33
Infectious disease	12.98±1.24	11.85±1.41	10.59±1.83	10.01±2.17
Post-operative surgery	13.22±1.15	**12.08±1.06**	**11.26±1.06**	**10.63±1.03**
F	**1.791**	**2.742**	2.043	**2.936**
P	**0.154**	**0.047***	0.113	**0.037***

* Significant at level P<0.05

Table (9): Correlation between level of consciousness of the studied critically ill patients and their laboratory investigations and severity of anemia throughout periods of study.

Lab data	The studied patients (n=100) Level of Consciousness							
	On Admission		At 3rd Day		At 5th Day		At 7th day	
	R	P	R	P	R	P	R	P
Hemoglobin	0.100	0.323	0.120	0.233	0.196	0.050	0.086	0.398
Hematocrit	0.107	0.291	0.051	0.614	0.095	0.349	0.048	0.633
RBCs count ($\times 10^3$)	0.061	0.546	-0.005	0.958	0.283	**0.018***	0.150	**0.013***
Severity of anemia	0.104	0.305	0.121	0.232	0.198	**0.048***	0.168	0.094

r: Pearson' correlation coeeficient

* Significant at level P<0.05

Table (10): Correlation between severity of anemia of the studied critically ill patients and their physiological indices throughout periods of study.

Parameter	The studied patients (n=100) Severity of anemia							
	On Admission		At 3rd Day		At 5th Day		At 7th day	
	R	P	R	P	R	P	R	P
Oxygen saturation	-0.025	0.808	-0.039	0.701	0.029	0.773	0.006	0.955
Heart rate	0.111	0.270	-0.141	0.161	-0.002	0.980	0.111	0.274
Respiratory rate	0.025	0.808	-0.101	0.317	-0.118	0.241	**-0.231**	**0.021***
MAP	0.112	0.268	-0.074	0.465	0.058	0.565	**0.221**	**0.027***
Blood pressure								
Systolic	0.121	0.231	-0.106	0.295	-0.026	0.799	0.145	0.149
Diastolic	0.158	0.117	-0.087	0.390	0.057	0.572	**0.227**	**0.023***
Body temperature	0.013	0.898	-0.187	0.063	-0.142	0.159	-0.143	0.156

r: Pearson' correlation coefficient

* Significant at level P<0.05

Discussion

Section I: Socio demographic Characteristic, Clinical data and Laboratory Investigation of patients.

The current study showed that majority in the (40-<50) years age group with mean ±SD (45.41±11.379). This could be due to that, younger patients were admitted to ICU due to other causes rather than chronic disease such as trauma and post-operative follow-up. These data are similar to **Rose, Mani&Nimbargi., (2023)** study findings that patients in the age group 30-45 years were the most represented .In contrast with **(Siddika ,Anowar ,Islam &Mallick., (2023)** who studied the socio demographic data of critically ill in ICU and reported higher incidence of the higher incidence of age group of more than 60 years. **Additionally**, the present study noted that ,the males and females were represented nearly equally with females consisting 51% of patients. These differences may be attributed to different locations and ICU specialties that cause differences in sex distribution, in the same line with findings, **Salah Hassan & Mohamed El-Metwaly**, (**2018)** study found that females represented 50.6% of their study cases. In contrast to finding found that, **Watson et al., (2024)** at males represented the higher percentage of their critically ill study cases.

Regarding diagnosis, patients with neurological diseases were the most represented among study cases, followed by cases admitted for post-operative causes. Contrary to study, stated that diseases as **Perao ,Bub ,Zandonadi &Martins.,(2017**)associated with circulatory system were the main cause of ICU admission. In opposition to these results, a study by to assess common **Nawaz et al., (2022**) critical care practices in the world found that sepsis was the predominant diagnosis followed by respiratory depression.

Concerning past medical and surgical history, nearly half of the patients had cardiac diseases. Additionally, over one-third of the patients were found to have diabetes. In contrast to the results, **Siddika et al., (2023)** showed that hypertension was the commonest disease as regard to medical history followed by diabetes mellitus. Also **Watson et al., (2024)** stated that hypertension was the commonest medical comorbidity in the study. **Atumanya et al., (2024) Also, Patient weight and caloric intake, The** study found that the mean weight of patients was (84.05±8.260). Also, their caloric intake mean was (2530.10±244.812).this result similar, found that their study **Yamamoto et al., (2020)** cases had mean weight of 82.2 kg. However, the caloric intake of their study cases was 1646.0 ±315.3. this could be due to the differences in min-max body weight of their study patients. It ranged from 42.1 to 145.7 kg compared to 60-98 of the study.

As regarding hemoglobin levels, mean hematocrit value and red blood cell count, it showed that their levels continued to decline throughout the ICU stay, being significantly lower on the 7^{th} day compared to the level at admission .This because of withdrawal of blood daily, wound care, patient with drainage and medication affect hemoglobin level. Reinforcing findings, who studied the effect **Cioc,Fodor ,Benedek Moldovan &Copotoiu .,(2015**) of blood sampling in ICU patients and stated that the majority of patients had lower hemoglobin level after ICU than that of admission. Conflicting with study, **Makam ,Nguyen ,Clark &Halm .,(2017)** studied the incidence, predictors and outcomes of HAA

and found that only one third of their study cases developed anemia.

Section II: Predictors of Hospital Acquired Anemia Assessment.

Regarding the modified APACHE score, it was found that the majority of patients (91%) had a poor outcome, indicating In contrary to observation, **Manal, Naglaa Kareem&Wael., (2020**) studied prevalence and prognostic implication of anemia in critically ill patients. They found that the majority of their study cases were classified as survivors while lower incidence was classified as non-survivors.

Concerning to predictors of hospital acquired anemia related to patient. Severity of anemia according to hemoglobin level; throughout the study period at 3rd day, all patients were classified as having mild anemia according to their hemoglobin levels. A significant occurred by the 3rd day, as the percentage of patients experiencing moderate anemia and severe anemia increased significantly as the study progressed, particularly by the 5th and 7th days. This comes in line with **Wubet et al.,(2024**) found that 66% of their study cases had anemia by the 3rd day of ICU admission and they had their anemia continued to get worse by time**.** In opposite to **Manal et al., (2020),** found that he prevalence of anemia at ICU admission varies, but it appears that 20-30% of patients have moderate to severe anemia (hemoglobin concentration <9g dl–1). Only 10-15% had documented pre-existing anemia.

Concerning Type of nutrition intake: changes in enteral nutrition were observed. By the 7th day, the majority of patients were receiving enteral nutrition; this approach aims to prevent further nutritional deterioration due to the disease or its treatment, thereby reducing mortality risks **(McClave et al., (2016); Pearcy et al., (2021); Stratton ,Beggs , holmes&Camood., (2021)**.

increased disease severity, while the remaining 9% had a good outcome, reflecting decreased disease severity. On the same line, **Holland ,Peralta Moss ,Fane &Uprichard ., (2020**)found that the mean APACHE score among their ICU patients indicated moderate to severe deterioration.

In contrast, there was no change in the use of parenteral nutrition, with the majority of patients not receiving this type of nutrition on both admission day and the 7th day. Similar to results, **Díaz Chavarro et al., (2024)** found that parenteral nutrition was used with about 3% of their study cases especially among critically ill patients. Deviating from results, revealed that 29.9% of their **Servia-Goixart et al., (2022)** study cases received parenteral nutrition and there was significant increase in type of nutrition shift from enteral to parenteral nutrition.

Regarding Total caloric intake through 24hrs: study data on types of caloric intake reveals significant differences in **enteral nutrition** over the study period. There was a noticeable increase in the mean enteral caloric intake from admission to 3rd and5th days, followed by a decrease on the 7th day. This variation suggests fluctuations in the patients' ability to tolerate and process enteral nutrition as their conditions evolved. Also, it may be attributed to deterioration of clinical status of most of study cases. In contrast, the mean **parenteral caloric intake** showed no significant changes throughout the study period.

Opposing results, **de Koning ,Koekkoek Kars &Van Zanten., (2020)** demonstrated that late energy intake of >110% was associated with decreased mortality in septic patients, whereas in non-septic patients, late medium energy intake (80%–110%) was associated with better survival, both compared with low energy intake. **Yamamoto et al., (2020)** studied certain formulas to add to

enteral nutrition of ICU patients and found that 50% of patients met their caloric requirements through their ICU stay.

This shows the fact that ICU patients are vulnerable to different causative bleeding factors such as hematomas at site of operation and drainage tubes and many other sources of bleeding.

Concerning administration of anemia inducing drugs, the majority of cases had **anticoagulant anti-platelets agents** with significant increase in their number at comparing between day of admission and 7th day of ICU stay. **In regard to antibiotic administration,** the majority of current study cases had ceftriaxone and quinolones with no change through study period. This may be attributed to the common practice of administration of prophylactic antibiotic to prevent hospital acquired infection especially with immunocompromised patients.

Additionally, the majority of study patients had **anti-inflammatory drug therapy** and **bone marrow suppressant drugs**. This finding aligns with **Asfour, (2016)**, who noted that the majority of studied patients were on medications affecting RBC production. Similarly, **McEvoy & Shander, (2013)** highlighted that bone marrow suppression, a complication of commonly administered ICU drugs like nephrotoxic agents and PPIs, contributes to anemia, bleeding, and the need for blood transfusions in ICU patients. Contradicting these results, **Abe et al., (2019)** found that only 30.5% of their study cases received antibiotic therapy in ICU.

Also recent trauma or surgery: three fourth of cases had recent trauma or surgery. This number increased at 7th day. This shows the effect of trauma or surgery on patient health and its effect on anemia development either due to the postoperative inflammatory state, use of certain anemia inducing drugs or possible pre-, intra-, or postoperative bleeding. **Loftus et al., (2018)** investigated post-injury anemia in critically ill blunt trauma patients. Trauma patients had higher levels of stress hormones and inflammatory markers, but lower bone marrow activity for producing red blood cells**.** Moreover**, Vanhala et al., (2022)** found that Severe anemia frequently occurs after an acute moderate to severe traumatic brain injury (TBI), typically developing within the first 48 hours following the trauma. Factors that may contribute to this anemia include extra cranial injuries.

Regarding invasive procedures ,it was found that the majority of cases had venous catheter. This is a common practice as it is used for fluids and drugs administration. Arterial catheter was used with more than half of cases at admission day. This was increased to about two thirds at 7th day. This can refer to the worsening clinical condition of certain cases indicating more invasive procedures such as arterial catheters for Arterial blood gases assessment.

In agreement with study, **Juárez-Vela et al., (2022)** showed that most of cases who developed iatrogenic anemia, used arterial and venous catheters, and their usage highly increased among sever cases, attributing that to the more need for blood sampling and laboratory investigations.

Drainage system & wound: it found that three fourth patient needed drainage system care on the 7th day and wound care increased through the study days. These factors could be predictors of anemia as they may be associated with inflammatory state and bleeding episodes. Also, infection of wounds or drain sites is considered strong predictor of HAA. These results are echoing with **Teixeira et al., (2022)** who revealed that the majority of their study cases had an invasive insertion technique as nasogastric tube or vesicle drainage system.

Phlebotomy: Number of cases who underwent phlebotomy increased from about half on admission up to three fourths on day 7th day. This can be attributed to the increased need for phlebotomy for diagnostic tests and investigations. Nurse-related malpractices, such as mishandling collected samples and having to repeat withdrawals, exacerbated the problem. Physician-related factors included ordering unnecessary investigations **Bodley , Levi ,Chan Friedrich& Hicks ., (2023).**Supporting results, a study highlighted current phlebotomy practices in a Canadian academic ICU, showing an average daily volume of 33.1 mL for lab testing, with an additional 15.0 mL discarded during vascular access. This underscores the importance of considering waste in phlebotomy practices **(Bodley et al., 2021).**Diverging from results, **Elmetwalli et al., (2021)** found that there was no significant correlation between HAA anemia and phlebotomy blood loss.

Section III:- Relation between diagnosis of the studied critically ill patients and their mean hemoglobin level:

In this study, noted different diagnosis groups showed decreased mean hemoglobin levels on 7th day. **Post-operative cases** had higher mean hemoglobin levels than that of other groups. This can be attributed to the fact that postoperative cases may receive blood transfusion intra and post-operative to compensate for their blood loss. These data align with **Cahill et al., (2021)**, who found that with implementing anemia prevention protocols, their study postoperative cases had higher levels of HGB.

Section IV:- Correlation between level of consciousness of the studied critically ill patients and their laboratory investigations and severity of anemia throughout periods of study:

The result showed no significant correlation between level of **consciousness and hemoglobin levels or hematocrit values**. This might be due to the multifactorial nature of consciousness levels in such patients, where factors other than hemoglobin levels and hematocrit values, such as underlying neurological conditions, medication effects, and overall metabolic state, play a significant role .However, when comparing it with **RBCs count**, there was significant correlation with the level of consciousness at the 5th and 7th day .In study by **Ruilan Yin, (2024)** to assess effect of anemia on prognosis of moderate to severe traumatic brain injury. They found that severe anemia is associated with poor prognosis and altered level of consciousness. Also, **Sarıçam & Sarıçam., (2023)** found that increased anemia severity is associated with poor prognosis. This comes supporting to **Yin & Wei, (2024)** study results. They found that increased anemia severity is associated with poor GCS scores in traumatic brain injury patients. In contrast to these findings, **Boskabadi et al., (2024)** found that anemia severity has no significant correlation with GCS score

Section V:- Correlation between severity of anemia of the studied critically ill patients and their physiological indices throughout periods of study:

It found that respiratory rate shows a significant negative correlation with anemia severity, suggesting that as anemia becomes more severe, respiratory rate increases. This trend may reflect the body's compensatory mechanisms as it adjusts to prolonged anemia. Additionally, mean arterial blood pressure (MAP) and diastolic blood pressure exhibits a negative correlation with anemia severity on the 7th day, indicating that patients with more severe anemia tend to have lower MAP.

This results echo those of **Faghih Dinevari et al., (2021)** who found that anemic patients were more vulnerable to developing poor outcome and ventilator need. **Muneyoshi**

Tanimura et al., (2017), found that anemia severity is associated with more deteriorated MAP and cardiovascular hemodynamics and may affect treatment course.

Conclusion

Based on the results of the present study, it can be concluded that:

There were statistical significance regarding hospital acquired anemia predictors related to patients throughout the period of study concerning to mean hemoglobin level, 24hrs calories intake, anticoagulants and anti-platelets therapy.

More than half of the studied patients had predictors of hospital acquired anemia related to nursing practice from admission to 7th day of the study.

The studied patients developed HAA during ICU stay .As well as, there were statistically significant relation between diagnosis, hemoglobin level and severity of anemia .More over their were significant relation between level of consciousness and physiological indices regarding respiratory rate and mean arterial pressure .Finally critically ill patients were highly susceptible for exposure of hospital acquired anemia predictors during ICU stay.

Recommendations

Based on the finding of the current study, it can be recommended that:

For nurses:

- Provide scientific courses that increase critical care nurses knowledge regarding to risk factors, etiology, preventive measures of hospital acquired anemia.
- Apply training programs for critical care nurses on the standard procedure for arterial and venous blood sampling, drainage and wound care to minimize arterial, venous puncture complications, reduce frequency of ABG samples and minimize blood volume loss as possible.

For Patients:

- Preform a comprehensive patient monitoring and assessment for early detection and intervention of hospital acquired anaemia.

For further research:

- Replication of this study with a large probability sample and different setting of the study is recommended.

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